Effect of Straw Mulch on Soil Environment and Crop Yield In Dry-land of China

Mingyuan Yang, Patrik Van Damme

(University of Gent, Belgium)

Abstract: The limiting factors for getting high yield of crop in dry-land are the fertilization and soil moisture shortage. Experiments were carried out with straw mulch method. The results showed that straw mulch could improve soil fertility, decrease soil volumetric weight, raise soil moisture content, reduce soil erosion, water use efficiency(WUE) increased by 25.5%. Water consumption decreased by 8.6 %, Promote crop growth, crop yield increased by 14.7 %, and raises the benefit of economy, ecology and society.

Key words: Straw mulch, Soil environment, Crop yield, Dry-land

1. Introduction

Dryland accounts for above 70 % of total farmland in China, found mainly in Northeast China, North China, Loess Plateau and Northwest China dryland area.

There are three outstanding problems in china's dryland farming. First, shortages in precipitation, surface water and ground water. Water resource per hectare in northern dryland area is only 1/5 of china's average. Second, infertility of soil. In the Loess Plateau area, good-quality farmland is only about 21 %, low-quality farmland above 48 % and some farmland is too poor to be farmed. Third, degradating ecological environment. Desertificated land and eroded land are mainly found in the dryland farming area.

There are lots of practices to accelerate China's dryland farming development. Of which, straw mulch is one of effective measures. Mulches may be used to several purposes. They can reduce water loss from the soil and stabilize soil to prevent wind and water erosion. Mulches suppress weeds and protect against temperature extremes. They improve soil structure and enhance fertility and increase yield without contaminating the soil.

2. Material and Method

Trial area is situated in Shanxi province. Annual precipitation is about 450 - 550 mm. Annual evaporation is more than 1800 mm. Considering the mulch resources which to get easily, in area of growing wheat, take wheat straw(haulm) as mulch. Haulm is applied on wheat field surface by 4500 kg /ha. In area of planting maize, take maize straw as mulch. Maize straw is covered on maize field surface by 5000 kg/ha. Contrast parts are certainly set.

3. Result and Analysis

3.1. Reducing Water Consumption

Straw mulches can reduce the evaporation of water from the soil by increasing a protective boundary between the soil and the air as well as shading the soil from the sunlight. Because straw mulch material usually has a great porosity than the soil, moisture in the soil does not easily move to the air boundary by capillary action, thus evaporation is reduced. Otherwise, when water droplets land on bare soil, the impact causes soil particles to fly in all directions, resulting in soil crusting and slow water infiltration. Straw mulches break the impact of the droplets, reducing soil erosion and crusting and increasing the penetration of water into the soil. Tests indicate that water consumption respectively reduce by 2.6 % and 8.4 % in wheat field and maize field. As is shown in table 1 and table 2.

Table 1. The Effect of Haulm Straw on Water Consumption

Treatment	Water storage in 0-200 cm soil layer (mm)		Precipitation in growing period (mm)	Water consumption (mm)	Reducing rate (%)
	Before sowing	Harvesting			
Haulm mulch	220.4	150.5	175.3	245.2	2.6
Contrast	220.4	143.9	175.3	251.8	

Table 2. Water Consumption of Maize on Straw Mulch

Treatment	Planting – shooting (mm)	Shooting – heading (mm	Heading – filling (mm	Filling – ripening (mm)	Whole growing period (mm)	Reducing rate (%)
Straw mulch	61.2	154.0	67.7	118.1	401.0	8.6
Contrast	63.3	161.9	66.4	147.4	138.9	

3.2 Improving Soil Structure and Enhancing Soil Fertility

As organic mulches decompose, they provide organic matter that prompts soil particles to aggregate. Large aggregates increase aeration and improve moisture condition in the soil. These conditions, in turn, encourage additional root development and biological activity, further enhancing soil structure. Organic mulches decompose releasing nutrients into the soil. In addition, they create a good environment for earthworms. Soil permeability is enhanced with the action of the earthworms.

3.3 Reducing Soil Erosion

The surface roughness of mulching field is greatly increased, thus they reduce soil wind erosion. Mulches enhance soil permeability and reduce overland runoff. They can obviously prevent or reduce soil water erosion. The result of field simulated test is shown in table 3.

3.4 Reducing Weed Growth

Annual weeds must germinate from seed each year, but they do not germinate if covered so that they are not in the light. Perennial weeds will grow through most mulch, but may be weakened by the effort to reach the light and the expenditure of additional food reserves to do so. In addition, because mulches can reduce or delay soil compaction, increasing water and air

permeation into the soil, it is also easier to manually remove weeds from non-compacted soils.

Table 3. The Effects of Straw Mulch on Runoff Silt Under Different Slope Gradients

Slope (^{o})	Rainfall intensity (mm/min)	Velocity of flow (cm/s)		Volume of flow ($cm^3/h.m^2$)		Runoff reduce rate (%)	Silt content (kg/m^3)		Silt reduce rate (%)
		Contrast	mulch	contrast	mulch		contrast	mulch	
5	0.78	13.30	6.30	0.3880	0.2390	38.4	11.8	2.0	83.0
	1.76	19.74	6.79	0.1417	0.0889	37.3	25.4	3.5	86.2
10	0.76	20.32	12.67	0.0971	0.0595	38.7	34.2	19.4	43.3
	1.77	28.27	14.52	0.1514	0.1350	10.8	72.0	19.7	72.6
15	0.76	21.60	13.17	0.1089	0.0789	26.7	57.1	44.4	22.2
	1.78	30.65	16.80	0.2183	0.1227	43.8	173.5	87.9	49.3

3.5 Increasing Water Use Efficiency and Crop Yield

Due to straw mulches having the effects as indicated above, they can increase water use efficiency (WUE) and crop yield. The test results are shown in table 4.

Table 4. The Effects of Straw Mulches on Crop Yield and WUE

Test area	treatment	Seeds per Ear or spike	1000 grain weight (g)	Yield (Kg/ha.)	Creasing rate (%)	WSU (kg/ha.mm)	Creasing rate (%)
Wheat field	haulm	27.7	30.5	2431.5	7.9	9.9	11.5
	contrast	26.9	29.7	2253.1		8.9	
Maize field	straw	524	412.1	10455	14.7	26.1	25.5
	contrast	509	393.0	9118		20.8	

4. Conclusion and Discuss

Through straw mulch test in dryland, to get the following results:
Straw mulches reduce water loss by decreasing the evaporation of water from the soil and increasing permeability.
Improve soil structure and enhancing soil fertility by mulch releasing nutrient into soil and increasing biological activity.
Reduce soil erosion by decreasing runoff and wind erosion.
Enhance water use efficiency and crop yield.

Straw mulches are economic, readily available and easily applied and removed. It is a simple and feasible measure for dryland farming.

References

Randy Creswell, Franklin Martin. 1998. Dryland Farming: Crops and Techniques for arid regions.
http:/www.acca21.org.cn/pp2-1.htm. Priority Programme for China's Agenda 21. Apriority 2 – Sustainable Agriculture.
Francesco Salamini. 2000. Sustainable Agricultural Production.
Wilfred Legg, Gerard Viatte. 2001. Farming systems for sustainable agriculture.
Miguel A. Altieri. 2002. Agroecology: principles and strategies for desiging sustainable farming systems.
Britt Faucette. 2001. New emphasis on managing organic residuals.
Li Zhengfang. 2002. Brifing of organic agriculture in China.
Mingyuan yang, Patrick Van Damme.2003. An environmental factor evaluation of crop growing in different agro-ecological zones in China.